**Activity Title: Density Driven Currents**

**Subject (Focus/Topic):** This lesson will allow students to visualize and comprehend the drivers and influences from density driven currents. The alignment to my Bering Sea Aleutian trip in August of 2011 is to be able to understand certain applications of CTD data as well as to understand the phenomena of the Bering Sea referred to as the "Cool Pool" by scientists aboard the Oscar Dyson while conducting the BASIS survey.

**Grade Level:** Can be applied for grades 8-12 with varying degrees of ability level as tweaked by instructor.

**Average Learning Time:** ~ 1 – 2 Lecture/Discussion Based classes to instruct on topic followed by 1 regular class (~45 min long) to apply content in hands on visual format.

**Lesson Summary (Overview/Purpose):** Students will partake in student driven class discussion to answer inquiry and phenomena of density driven currents which regulate global climate. This will be followed by discovery-based lab demonstration. Students will explore density currents and their relation to the oceanic circulation system and fisheries distribution through laboratory experiment.

**Overall Concept (Big Idea/Essential Question):**

How do density differences in seawater drive deep ocean circulation?

What makes water "subside"?…or How to initiate a density current.

**Specific Concepts (Key Concepts):**

A density driven circulation which is driven by the differences in the density of seawater at different locations. The density of seawater depends on its temperature and how salty it is. As a result, this movement is known as the Thermohaline circulation (Greek: thermo = heat, háls = salt).

**Objectives/Learning Goals:**

1. Students will observe what happens when water of different temperatures (i.e. – Cold and Hot water) are mixed together.

2. Students will observe what happens when water of different salinities ( i.e. – salty and less salty) are mixed together.

3. Students will learn how differences in temperature and salinity affect the movement of ocean waters.

4. The student will be able to compare wind-driven and thermohaline circulation by completing a Venn diagram.

5. The student will be able to describe how variations in water density influence vertical ocean circulation by analyzing temperature and salinity diagrams.

6. The student will learn that the oceanic and atmospheric conditions that lead to variations in the density of seawater occur over very small regions of the Earth's surface

7. Student will learn that motion arises when materials of different density come into contact with one another

8. Student will learn that the density-driven circulation of the ocean is important to climate.

**Background Information:**

· The saltier water is denser than the less salty water so it sinks.
· Leave the tank for a few hours and notice whether the waters mix. Compare with the temperature experiment (salt mixes more slowly than temperature).
· The most saline waters are found at the ocean surface, in regions where the removal of fresh water (by evaporation) is greater than the input of fresh water (by precipitation).
· Differences in salinity can drive ocean currents. Usually there are temperature differences that enhance the density differences. Oceanographers use salinity as an ocean tracer.

**Common Misconceptions/Preconceptions:** State any common preconceived ideas or misconceptions that students may have about the topic of the lesson.

**Materials:**

Blue and red food coloring

Large Aquarium. I used a 50 gallon marine aquarium.

Hot Plate

Ice

Aluminum Foil

Rubber Bands

250 Ml Beakers

**Technical Requirements:** Not Applicable.

**Teacher Preparation:** Heat water on hot plate in sufficient time to get temperatures hot (not boiling). Chill Water with Ice with sufficient time as well to get desired temps. Fill tank with water.

Put aluminum Foil over both the heated and cooled water, secure with rubber bands. Poke small holes into the aluminum foil to allow water to dissipate out of the beakers (250ml)

**Keywords:**

**Thermohaline**

**Density**

**Ocean Current**

**Convective Currents**

**Thermal Energy Distribution**

**Pre-assessment Strategy/Anticipatory Set (Optional):** Perhaps an anticipatory visual cue would be appropriate. For example, a picture of the globally distributed density driven currents. Have students hypothesize possible drivers of these currents.

**Lesson Procedure:** Initiate Classroom Conversation about distribution of heat and energy from equatorial regions poleward. The picture prompt may be useful or a series of questions posed as a "Do Now" format. After several hypotheses are discussed, have students view teacher – led demonstration. I like to remain quiet during the actual demonstration and students become involved asking questions to each other. This leads to a student-drive, inquiry based lesson.

Simply fill 50 gallon tank with room temp fresh water. Have two 250 ml. beakers. One with the heated water, one with the chilled water. Color the chilled water with Blue Food Coloring and red for the hot. Secure aluminum to the top of these beakers using rubber bands. Poke small holes into the aluminum foil to allow water to flow out. Slowly lower the two temperature beakers to bottom of tank and tip them on there sides 90 degrees to allow colored waters to flow freely. The warm red colored water should rise to the surface and the cold blue colored water should subduct and occupy the bottom of the tank. After some time, mixing will occur in a convective current style.

Alternate format is to have class broken into smaller groups and allow them to conduct this "experiment" in small group settings.

An extension to this is to simply make a hyper-saline solution and color it a third unique color and add this to the tank(s) as well. Students should draw conclusions about density of water as influenced by Salinity.

**Assessment and Evaluation:**

Students will be assessed informally by determining level of engagement within group / class setting as well as Formative assessment given in form of quiz administered at the end of class. The quiz involves students utilizing the key terms in paragraph format in a scientifically accurate fashion to demonstrate understanding.

**Standards:**

- **National Science Education Standard(s) Addressed:**

***Teaching Standard B***

Teachers of science guide and facilitate learning. In doing this, teachers focus and support inquiries while interacting with students.

- **Ocean Literacy Principles Addressed:**

**The Earth has one big ocean with many features.**
**c.** Throughout the ocean there is one interconnected circulation system powered by wind, tides, the force of the Earth's rotation (Coriolis Effect), the Sun, and water density differences. The shape of ocean basins and adjacent land masses influence the path of circulation.

**State Science Standard(s) Addressed:**

**Standard: 5.4 Earth Systems Science:** All students will understand that Earth operates as a set of complex, dynamic, and interconnected systems, and is a part of the all-encompassing system of the universe

**Strand: F. Climate and Weather:** Earth's weather and climate systems are the result of complex interactions between land, ocean, ice, and atmosphere.

**Additional Resources:** / Extension

http://www.pbs.org/newshour/extra/teachers/lessonplans/science/jan-june08/polar_oceanography_extension_currents.pdf

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